

Global Instability of Internal Waves in Low-Mass, Stably Stratified Protoplanetary Disks

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Observations and theory indicate that a low-mass star forms by accreting material from a gaseous, dusty disk orbiting a central protostar. Accretion onto the protostar can not proceed unless the angular momentum of infalling material is somehow transferred to the environment. Identifying important mechanisms for transporting angular momentum away from the protostar is thus vital for understanding the evolution of Protoplanetary disks around young stars that might form planetary systems. Here I explore the ability of a class of low-frequency internal waves (r-modes) to effectively transport angular momentum radially outward over large distances in 3-D protoplanetary disks. Attention is focused on the propagation of these modes in disks possessing stable vertical stratification, i.e., in disks where small-scale convection is inhibited in the direction perpendicular to the midplane. The stable stratification produces a waveguide in such that the corotation resonance is imbedded within a radially thin forbidden zone that separates wave propagation regions lying on opposite sides of the resonance. This configuration is likely to promote overreflection of r-modes at their corotation resonance. Overreflection, combined with radial containment of the waves by their Lindblad resonances or the inner edge of the disk, suggests a mechanism for global r-mode amplification reminiscent of the SWING mechanism proposed for spiral density waves in self-gravitating disks. This r-mode instability may be effective in transporting angular momentum in relatively low-mass, gravitationally stable disks. Calculations of the reflection and transmission properties of r-modes at their corotation resonance will be discussed.